Description

STRUCTURAL WALLS

Related Applications

This is a continuation-in-part of my co-pending application Serial No. 10/387,982, entitled Structural Walls and Construction Method, filed March 3, 2003, as a continuation-in-part of my prior application Serial No. 10/035,488, entitled Slotted Metal Stud, filed October 19, 2001, filed as a continuation-in-part of my prior application Serial No. 09/293,074, filed April 16, 1999, entitled Wall Beam And Stud, and now U.S. Patent No. 6,374,558 B1, granted April 23, 2002.

Technical Field

The present invention relates to wall structures composed of sheet-metal frame members and to a method of constructing wall structures from such sheet-metal frame members. More particularly, the invention provides a wall structure in which a horizontal frame member at the top of the wall structure, and an overhead structure to which it is connected, are able to move vertically relative to the remainder of the wall structure, such as during an earthquake or as settlement occurs.

Background of the Invention

My aforementioned U.S. Patent No. 6,374,558 includes a comprehensive Background of the Invention. Additional background information is set forth by U.S. Patent No. 4,805,364, granted February 21, 1989 to Robert A. Smolik; by U.S. Patent No. 5,127,203, granted July 7, 1992 to Robert F. Paquette; by U.S. Patent No. 5,127,760, granted July 7, 1992, to Todd A. Brady; by U.S. Patent No. 5,685,121, granted November 11, 1997 Frank De Framcesco and Joseph D. Alumbo; and by U.S. Patent No. 5,313,752, granted May 24, 1994, to Michael A. Hatzinikolas.

A problem with most of the systems disclosed by Smolik 4,805,364; Paquette 5,127,203; Brady 5,127,760 and DeFramesco et al. 5,313,752 is that the components of the systems are expensive to manufacture. Another problem of the systems disclosed by Paquette 5,127,203 and Brady 5,127,760 is that the upper frame members are weakened by the way they are constructed. An object of the present invention is to provide a construction of the frame members which renders them economical to manufacture and results in stronger upper frame members and a stronger wall structure.

As disclosed in the above-identified patents, the horizontal and vertical frame members are constructed from sheet-metal and are channel shaped. The upper horizontal frame member is in the form of a downwardly opening channel member having opposite sidewalls and a web that extends between the upper edges of the sidewalls. The lower frame member is in the form of an upwardly opening channel member. It has opposite sidewalls and a web that extends between the lower edges of the sidewall. The vertical frame members (or "studs") are also channel-shaped, except that they include also lips which extend inwardly in coplanar parallelism from the edges of the sidewalls that are distal the web.

The systems disclosed by Paquette 5,127,203 and Brady 5,127,760 each include an upper channel member having screw receiving slots in its sidewalls. The upper ends of the studs are positioned within the upper channel member between a pair of opposed slots, such as shown by Fig. 1 of Brady 5,127,760. The upper channel members are typically provided with a large number of slots so that there is a large number of places to secure the studs to the upper frame member. Consequently, most of the slots in the upper channel member remain unused in a given application. Although they are unused, they still require a cost to make, and there presence acts to weaken the upper channel member.

In the systems disclosed by Paquette 5,127,203 and Brady 5,127,760, the slots in the upper channel members are outside of the upper end portions of the studs. Sheet-metal screw fasteners extend through the slots and are screwed into the sidewalls of the upper ends of the studs. The screws are intended to slide in the slots during vertical movement of the studs relative to the upper frame members. When the screws are tightened too much, which happen often, the studs are clamped between the heads of the screw fasteners and the upper end portions of the studs. This clamping retards and often prevents movement, often causing damage to the wall structure.

De Framcesco et al. 5,685,121 discloses studs composed of telescopically connected upper and lower portions, making them costly to manufacture. The sidewalls of one of the end portions includes longitudinal slots. Screw fasteners extend through the sidewalls of the other end portion and extend into the slots. The upper end portion fits snugly within the downwardly extending channel space of the upper frame member. The upper end of the upper end portion extends upwardly to the web of the upper frame member.

An object of the present invention is to provide a simplified framing system in which the screw fasteners used to secure the studs to the channel members can be tightened without causing the sidewalls of the upper channel member to be clamped between the sidewalls of the studs and the heads of the screw fasteners.

Another object of the present invention is to provide a system which obviates the high cost of manufacturing the upper channel member and maintains the studs free for vertical movement relative to the upper channel member. Another object of the invention is to provide a system in which the placement of the studs is not limited to the location of preformed slots in the sidewalls of the upper channel member, but rather the studs can be placed at any location along the upper channel member and then be connected to the upper channel member at that location and remain free to move vertically relative to the upper channel member.

A further object of the present invention is to provide a system which includes a pattern of selectively useable screw location indicators in a sidewall of an upper channel member, or similar other member, to facilitate placement and assembly of screw fasteners.

Brief Summary of the Invention

A structural wall according to the present invention is basically characterized by an elongated, downwardly opening, sheet-metal, upper channel member having spaced apart sidewalls which define an upper channel space between them, and by sheet-metal studs. The sheet-metal studs include upper end portions sized to fit within the upper channel space. The upper end portions of the studs comprise sidewalls that are contiguous the sidewalls of the upper channel member when the upper end portions of the stud are within the upper channel space. At least one sidewall of the upper end portion of each stud includes a longitudinal slot positioned for receiving the shank portion of a screw fastener. The slot is wider than the shank portion of the screw fastener and is long enough to permit a desired amount of vertical movement of the stud relative to the screw fastener and the upper channel member. The screw fasteners are adapted to be tightened to firmly connect them to the sidewalls of the upper channel member. The shank portions of the screw fasteners are in the slots, free of connection with the upper end portions of the studs. During wall movement, the studs can move up and down relative to the screws and the upper channel member. There is no

clamping of the sidewalls of the upper channel member between the heads of the screw fasteners and the upper end portions of the studs.

In preferred form, there is a longitudinal slot in each sidewall of the upper end portion of the stud and there are two screw fasteners for each stud, one for each slot. Each screw fastener is connected to a different one of the sidewalls of the upper channel member and each extending into and through the slot in the contiguous sidewall of the stud. In preferred form, the structural wall comprises the aforementioned sheet-metal upper channel member, and a sheet-metal lower channel member having spaced apart sidewalls defining a lower channel space between them. A plurality of elongated studs are spaced apart in parallelism and each said stud includes an upper end portion positioned within the upper channel space and a lower end portion positioned within the lower channel space. The lower end portion of each stud has spaced apart sidewalls that are contiguous the sidewalls of the lower channel member. Screw fasteners firmly connect the sidewalls of the lower channel member to the sidewalls of the lower end portions of the studs. The upper end portions of the studs and the upper channel members are constructed and arranged in the manner previously described. There are slots in the upper end portions of the studs and screw fasteners are connected to the sidewalls of the upper channel member. The screw fasteners include shank portions that extend into and through the slots in the studs.

According to an aspect of the invention, the sidewalls of the structural members through which the screw fasteners pass before they extend into the slots is provided with a plurality of selectively useable screw position markers in the form of dimples in the sheet metal. In use, a slot containing structural member is positioned with its slot behind a selected dimple, and the leading end of the screw is set into the dimple and the screw is rotated to cause it to bore through the bottom of the dimple and enter into the slot. Preferably, the screw has a flight diameter that is larger than the width of the slot. It also has a head and a portion immediately inwardly of the head that has a width or diameter that is smaller than the width of the slot. When the screw is installed, this portion of the screw is in the slot and the end of the flight that is adjacent the head of the screw is positioned endwardly of the wall that includes the slot. As a result, the shank of the screw can slide lengthwise of the slot and any force applied to the system tending to cause the screw to move endwise will be countered by a contact between the end of the slights and the metal on opposite sides of the slot.

According to a method of the invention, an upper channel member is supported in an overhead position with its channel space directed downwardly. The lower channel member is secured in a position below the upper channel member, with its channel space confronting the upper channel space. A plurality of studs are spaced apart in parallelism with each other. The lower end portions of the studs are positioned within the lower channel space and the upper end portions of the studs within the upper channel space. The studs are moved sideways along the upper channel members to place them in desired positions. Then, screw fasteners are inserted through the sidewalls of the upper channel member at locations outwardly of the slots in the upper end portions of the studs. The screw fasteners are firmly secured to the sidewalls of the upper channel member, with their shank portions extending inwardly through the slots. The screw fasteners are free of connection with the studs. The sidewalls of the upper channel members are not clamped between the heads of the screw fasteners and the upper end portions of the studs.

Preferably, the screw fasteners that are used comprise a head and a shank. The shank is threaded throughout a substantial portion of its length but it includes a non-threaded portion between the head of the screw and the threaded portion. The threaded portion has an end thread closely adjacent to the head. The end thread is spaced from the head a distance greater than the thickness of the side wall of the upper channel member and the flange of the stud which includes the slot. The end thread is wider than the slot so that the threaded portion of the screw cannot be moved through the slot. When the screw is in place, the head is adjacent to the side wall of the upper channel member, the flange of the stud that includes the slot is adjacent the side wall of the upper channel member, and the end thread is adjacent the metal portions of the stud on opposite sides of the slot. As a result of this construction, a side force acting on the wall lengthwise of the screw will be resisted by contact between the end thread and the portions of the studs that border the slot.

Other objects, advantages and features of the invention will become apparent from the description of the best mode set forth below, from the drawings, from the claims and from the principles that are embodied in the specific structures that are illustrated and described.

Brief Description of the Several Figures of the Drawing

Like reference numerals are used to designate like parts throughout the several views of the drawing, and:

Fig. 1 is a fragmentary pictorial view of a sheet-metal stud, an upper sheet-metal channel member, and a portion of a wall board panel, such view being taken from above and looking towards the top and one side of the structure that is illustrated, and towards the open side of the studs, such view showing a line of dimples on the side wall flanges of the upper channel member;

Fig. 2 is an enlarged scale fragmentary, pictorial view of a sheet-metal stud, an upper sheet-metal channel member, and a lower sheet-metal channel member, with a center portion of the stud being cut away for the purpose of indicating indeterminate length;

Fig. 3 is a still larger scale elevational view, with parts in section showing a screw in alignment with a dimple in a side wall flange of the upper channel member and a slot in an upper portion of a stud that is in alignment with the dimple;

Fig. 4 is a view like Fig. 3 but showing the screw installed;

Fig. 5 is a sectional view on an enlarged scale, taken along line 5-5 of Fig. 4;

Fig. 6 is a sectional view taken substantially along line 6-6 of Fig. 4;

Fig. 7 is an enlarged scale view of the upper channel member, showing a screw in alignment with a dimple in one of the flanges of the channel member;

Fig. 8 is a view of a pair of rollers in the process of being used to form the dimples in the sheet-metal;

Fig. 9 is an enlarged scale view of the central portion of Fig. 8; and

Fig. 10 is front elevational view looking towards a dimple.

Detailed Description of the Best Mold

The aforementioned U.S. Patent Application Serial No. 10/387,982 contains a detailed description of many of the features of the structural wall of the present invention. Rather than repeating the entire disclosure of application serial no. 10/387,982, that application is hereby incorporated herein by this specific reference.

Referring to Figs. 1 and 2 herein, the framing structure that is illustrated in the drawing comprises a downwardly opening upper channel member 10, an upwardly opening lower channel member 12 (Fig. 2) and a plurality of studs 14. All three of these members 10, 12, 14 are constructed from sheet-metal. The upper channel member 10 is connected to a suitable overhead support and the lower channel member 12 is connected to a suitable lower support. Channel member 10 includes side walls or flanges 16, 18 connected together at their

upper edges by a web 20. The side walls or flanges 16, 18 depend from the web 20 and the three members 16, 18, 20 form an upper channel space 22. The lower channel member 12 comprises first and second side walls or flanges 24, 26 that are interconnected by a bottom web 28. Members 24, 26, 28 form an upwardly opening channel space 30. When channel members 10, 12 are within the wall structure they are spaced apart vertically and the channel space is 22, 30 confront each other.

The studs 14 each include an upper end portion 32 and a lower end portion 34. The lower end portion 34 fits down inside the channel space 30. Screw fasteners extend through openings 36, 37 and side walls 24, 26 and firmly connect the side walls 24, 26 (and hence the lower channel member 12) to the lower end portions 34 the studs 14. The upper end portions 32 of the studs 14 fit within the upper channel space 22. As shown in several of the views, the studs 14 have upper ends that are spaced downwardly from the web 20. The studs 14 have opposite side walls or flanges 38, 40 that are connected together along opposite side edges of a web 42. The opposite edges of the flanges 38, 40 are provided with lips 44, 46 that turn inwardly and extend in co-planar parallelism with each other. The side walls or flanges 38, 40, the web 42, and the lips 44, 46 form a lipped channel construction.

As shown by several figures of the drawing, the side walls 38, 40 of the upper end portions of the studs 14 are provided with longitudinal slots 48, 50, having closed upper and lower ends. As shown by Figs. 1-5, for example, the upper end portions 32 of the studs 14 extend only part way into the upper channel space 22 in the upper channel member 10. The upper ends of the studs 14 are thus spaced downwardly from the web 20. This provides a vertical space within the channel space 22 below the web 20 in which the upper ends of the studs 14 can move in the vertical direction.

Screw fasteners 52 extend inwardly through the side walls 16, 18 of the upper channel member 10 and then extend into and through the slots 48, 50. Each screw 52 has a head 54 at one end and a pointed opposite end 56. There is a shank between the head 54 in the plated end 56. A portion of this shank, designated 58, includes helical threads 60, there is a portion of the shank 62 that is between a head 54 and the end thread 64 closest to the head 54 that is not threaded. When the screw 52 is installed, the non-threaded portion 62 of the shank 58.

Figs. 5 and 6 show the non-threaded portion 62 of shank 58 positioned within the slot 48. Shank portion 62 may have a circular cross-section, as shown in Fig. 6. The important

thing is that the shank portion has a width that is narrower than slot 48. End thread 64 of the threads 60 is positioned so that when the screw head 54 is against the wall 16 of channel member 10, thread 64 is contiguous the metal on the two sides of the slot 48. Fig. 6 shows that the end thread 64 has a diameter that is larger than the slot 48 is wide. The axio distance d, between the inside surface of the head 54 and the closest portion of the end thread 66 is slightly longer than the combined thicknesses of walls 16, 32. As a result, there is no clamping of the sheet-metal members 16, 32 between the screw head 54 and the end thread 64. As a result, relative movement of the screw shank portion 62 is permitted in the slot 48. If the upper channel member 10 is forced downwardly relative to the stud 14, the screw shank portion 62 will move downwardly lengthwise of the slot 48. If the stud 14 wants to move upwardly relative to the upper channel member 10, the slot 48 will move relative to the first shank portion 62. If a sideways force is applied against the wall, in one direction the screw heads 54 will be forced against member 16. In the opposite direction, the thread ends 64 will be moved against the portions of stud walls 32 that border the slot 48. In either event, the sideways forces are carried at the screw connections. Accordingly, this construction allows relative movement in the vertical direction, such as might occur during an earthquake or because of settling, while the walls brace at least to some extent in the sideways direction. Thus, the wall is better able to resist wind loads and other types of side loads that it might encounter.

As well disclosed in Serial No. 10/387,982, wall board sheeting WB is attached to the assembly composed of the studs 14 and the lower channel member 12. The wall board sheeting WB is free of connection to the upper channel member 10. This allows the upper channel member 10 and the structure to which it is attached to move relative to the assembly 12, 14 and the structure to which it is attached. This movement is a movement in the vertical direction, lengthwise of the slots 48. As explained above, in response to lateral forces acting on the wall, the screw fasteners 52 will act to transmit forces so that the wall will act to resist these forces.

As previously mentioned, an advantage of the invention is that the placement of the studs is not limited to the location of pre-formed slots in the side walls of the upper channel member. Rather, the studs can be placed at any location along the upper channel member and then be connected to the upper channel member at that location and remain free to move

vertically relative to the upper channel member. However, in some installations, it is possible to have set locations for the screws. In that case, it is desirable to provide a dimple in the side walls 16, 18 at each screw location. These dimples are designated 70 in Figs. 3 and 7-10. By way of example, the dimples 70 may be spaced one inch apart lengthwise of the wall 16. The screw 52 may have a self-tapping end 56. In that case, the end 56 is placed into a selected dimple 70 and the screw is rotated to form a hole through the wall 16, 18 at the location of the dimple 70. The dimple 70 will keep the screw in line as the hole is being formed. Without the dimple 70, the screw 52 may want to move or "walk" in response to the turning force applied to it by a screw driver.

Figs. 8 and 9 show that the dimple 70 may be formed by a pair of wheels 72, 74. Wheel 72 is shown to include a plurality of projections 76. Wheel 74 includes corresponding recesses 78. The sheet-metal member 16, 18 is moved through the nip formed by the wheels 72, 74. As the wheel 72, 74 turn, they move within the sheet-metal member 16, 18. In succession, a projection 76 moves against a spot on the sheet-metal member 16, 18 and moves it into a recess 78. This forms the dimples 70.

The illustrated embodiments are only examples of the present invention, and therefore, are non-limitive. It is to be understood that many changes in the particular structure, material and features of the invention may be made without departing from the spirit and scope of the invention. Therefore, it is my intention that my patent rights not be limited by the particular embodiments illustrated and described herein, but rather are to be determined by the following claims, interpreted according to accepted doctrines of patent claim interpretation, including use of the Doctrine of Equivalence and Reversal of Parts.